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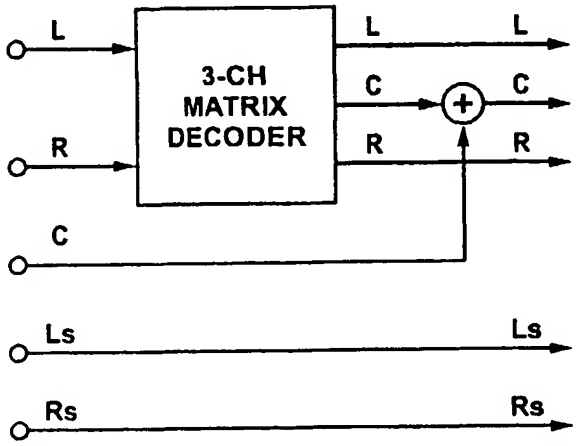
(54) Title: METHOD AND APPARATUS FOR MULTICHANNEL LOGIC MATRIX DECODING




(57) Abstract: The present invention improves the stability of aural images in the decoding of multichannel signals. Output center-channel and back-surround channel signals are derived or augmented by applying signal processors such as matrix decoders to multichannel input signals.

WO 03/028407 A2

A similar benefit may be obtained for surround channel signals by applying logic matrix decoders in multichannel systems such as those systems providing conventional 5 or 5.1-channel discrete source signals. In this application, which is called Surround EX, a logic matrix decoder is fed with the Ls and Rs signals of a 5-channel soundtrack to derive three surround channels (Ls, Bs, Rs) from the original two. Fig. 1 provides a block diagram of this application. Listeners seated off center are better able to sense the directional cues intended to come from between the Ls and Rs channel loudspeakers.

With the advent of DVD audio, 5.1-channel audio programs are becoming more commonplace. One might expect the problem with sound field collapse will be easily avoided with 5.1-channel systems because they provide a discrete center channel. Unfortunately, the problem will not be avoided because these systems afford additional flexibility in how vocal signals are mixed among the three front channels. In some cases, vocal signals are mixed as before, exclusively in the L/R channels, to create a phantom center image. In other cases, vocal signals are mixed into only the center channel. In yet other cases, vocal signals are mixed into all three front channels in varying proportions. While these mixing choices may affect the integration or clarity of the vocal signals, in most cases the vocals are intended to be perceived as emanating from the center of the soundstage. For those mixes that place vocal and other central signals into the L/R channels rather than the center channel, sound field collapse will still occur for listeners that are not situated in or near a central listening location.

For listeners seated off-center, a mix with vocal signals only in the center loudspeaker will impart an aural image of the vocal signals closest to center of the soundstage independent of listener location. As the center channel is used proportionally less, the vocal image shifts towards the listener's location. This is similar to the problem already described for two-channel sources; however, the solution to the problem is complicated by the presence of the center-channel signal. A 5.1 channel program with vocal signals in only the center channel can preserve a central aural image despite listener location and does not need any further modification. A program that uses only the L and R channels has the same limitations as standard two-channel recordings, and programs that place vocal signals into the L, C and R channels will produce central aural images having locational stability

including a first output signal path coupled to the first output of the signal processor, a second output signal path coupled to the second output of the signal processor and a third output signal path coupled to the third output of the signal processor.

According to yet another aspect of the present invention, an audio decoding method comprises receiving a left-channel input signal, a right-channel input signal and a center-channel input signal; deriving from the left-channel and the right-channel input signals a plurality of processed signals that includes a left-channel processed signal, a right-channel processed signal and a center-channel processed signal; combining the center-channel input signal and the center-channel processed signal; and providing a plurality of output signals representing the left-channel processed signal, the right-channel processed signal, and the combined center-channel input signal and center-channel processed signal.

## BRIEF DESCRIPTION OF DRAWINGS

Fig. 1 is a block diagram of a multichannel audio decoder with Surround EX decoding.

Fig. 2 is a block diagram of a multichannel audio decoder that redistributes center channel signals.

Fig. 3 is a block diagram of a multichannel audio decoder with a hybrid discrete/matrix 3-channel processor.

Fig. 4 is a block diagram of an audio decoder for a matrix-enhanced five-channel system.

## MODES FOR CARRYING OUT THE INVENTION

More particular mention is made of "vocal signals" and "vocal images" in this disclosure because musical programs of two or more channels typically are designed to present these types of signals at the center of the sound stage. The present invention may be applied to any type of signal and is not limited to vocal signals. References herein to vocal signals and the like should be understood to refer to any type of aural signal that is intended to be presented at or near the center of the soundstage.

One implementation of a system that can provide a stable central aural image is illustrated in Fig. 2. In this implementation, the C channel signal is distributed or mixed into the L and R channels to provide a two-channel signal. The vocal signals pre-existing in the C channel are mixed into both L and R channels at the same level. The resulting two-channel signal is then processed to derive three channels (L, C and

## CLAIMS

1. An audio decoder that comprises:

a plurality of input signal paths including a first input signal path that conveys a left-channel input signal, a second input signal path that conveys a right-channel input signal and a third input signal path that conveys a center-channel input signal;

a signal processor having inputs coupled to the first and second input signal paths and having a plurality of outputs that provides processed signals derived from the left-channel and right-channel input signals, wherein a first output provides a left-channel processed signal, a second output provides a right-channel processed signal and a third output provides a center-channel processed signal;

a signal combiner having inputs coupled to the third input signal path and the third output of the signal processor, and having an output that provides a signal representing a combination of the center-channel input signal and the center-channel processed signal; and

a plurality of output signal paths including a first output signal path coupled to the first output of the signal processor, a second output signal path coupled to the second output of the signal processor and a third output signal path coupled to the output of the signal combiner.

2. The decoder of claim 1 wherein the signal processor is implemented by a logic matrix decoder.

3. An audio decoder that comprises:

a plurality of input signal paths including a first input signal path that conveys a left-channel input signal, a second input signal path that conveys a right-channel input signal and a third input signal path that conveys a center-channel input signal;

a signal processor having inputs coupled to the first, second and third input signal paths and having outputs that provide processed signals derived from a mix of the left-channel and center-channel input signals and a mix of

deriving from the left-channel and the right-channel input signals a plurality of processed signals that includes a left-channel processed signal, a right-channel processed signal and a center-channel processed signal;

combining the center-channel input signal and the center-channel processed signal; and

providing a plurality of output signals representing the left-channel processed signal, the right-channel processed signal, and the combined center-channel input signal and center-channel processed signal.

7. The decoding method of claim 6 wherein the left-channel processed signal, right-channel processed signal and center-channel processed signal are derived by applying a logic matrix decoder to the left-channel and the right-channel input signals.

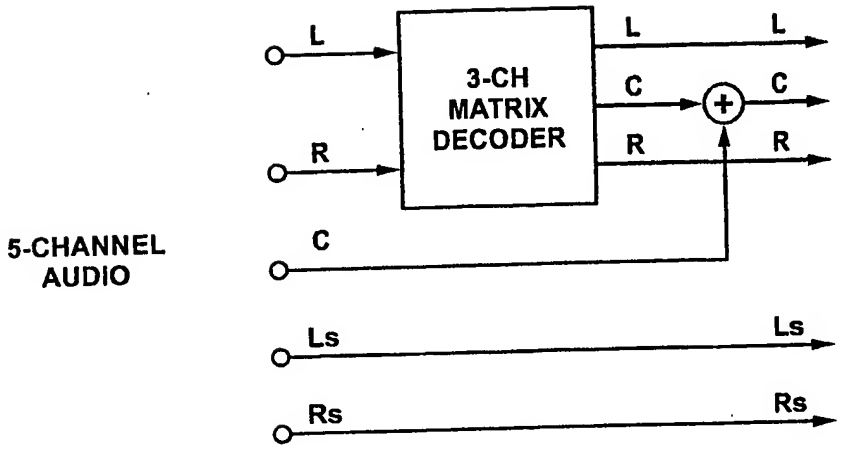
8. The decoding method of claim 6 or 7 that comprises:

receiving a surround-channel input signal;

deriving from the left-channel and the right-channel input signals a surround-channel processed signal;

combining the surround-channel input signal and the surround-channel processed signal; and

providing an output signal representing the combined surround-channel input signal and surround-channel processed signal.


5-CHANNEL AUDIO
L
R
C
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Rs
3-CH MATRIX DECODER
L
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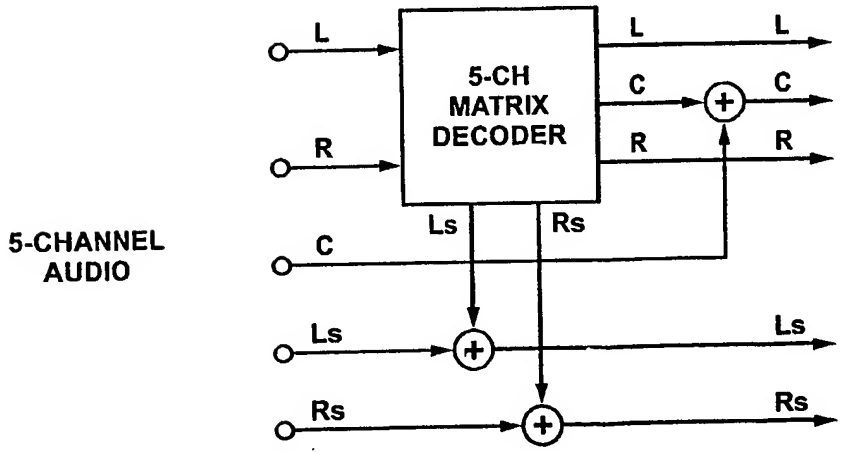
L
C
R
Ls
Rs

Fig. 3


5-CHANNEL AUDIO
L
R
C
Ls
Rs
5-CH MATRIX DECODER
L
C
R
Ls
Rs
L
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Ls
Rs

Fig. 4

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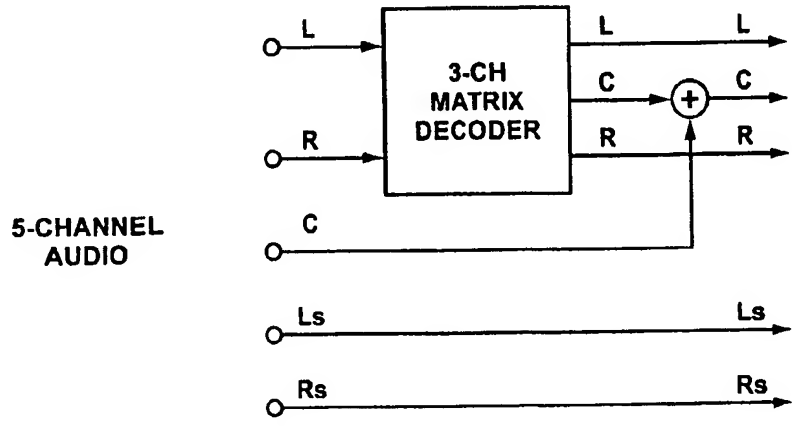


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## INTERNATIONAL SEARCH REPORT

Information on patent family members

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